CLAIMS

We claim:

1   1. A method for locating neighbor objects of a query geometry in a database, the method

2   comprising:

3   1) tiling a query geometry at a tiling level t;

4   2) conducting a search of a search area comprising interior and boundary tiles of the

5   query geometry for neighbors, if the search does not produce a result set that includes a target

6   number of neighbors, then the following steps are carried out starting with a radius r of 1:

7   3) expanding the search area to a radius r tiles at a distance d from the boundary

8   tiles and conducting a search for neighbors in the expanded search area, where $(r-1)*tw <$

9   $d \leq r*tw$, wherein tw is the maximum or minimum of the x-width, y-width of a tile at

10   level t and r is the query radius;

11   4) using each tile in the expanded search area it is determined if there are any

12   geometries at distance $\leq r*tw$ that are to be included in the result set;

13   5) if a target number of neighbors is not found, steps 3-4 are repeated with a query radius

14   of 2 tile widths followed by 3 tile widths;

15   6) if the target number still is not reached retiling the query geometry at a higher level of

16   tiling; and

17   7) repeating steps 1-7 until either the target number is reached or all objects in the

18   database are searched.

1   2. The method according to claim 1, wherein geometries at distances $>r*tw$ are included

2   in the search with query radius r.

1   3. The method according to claim 1, wherein only a portion of tile in the expanded query

2   radius are materialized prior to searching the expanded query radius for neighbors, and wherein

3   additional tiles are materialized until all tiles at a specific query radius have been generated,

4   searched and included in a result.

1   4. The method according to claim 3, wherein about 1000 to about 5000 tiles are

2   materialized prior to searching.

6. The method according to claim 3, further comprising removing duplicate neighbors

2   from the result.

7. The method according to claim 3, further comprising:

      retaining only the target number of neighbors if more than the target number of

3   neighbors is found and terminating the searching process.

1   8. A method for locating neighbor objects of a query object in a database, the method

2   comprising:

3   defining a query tile set comprising a plurality of tiles that define an initial query radius

4   that the query object is grouped within;

5   locating neighbor objects within the initial query radius;

6   determining a number of neighbor objects within the initial query radius;

7   expanding the query radius beyond the initial query radius by defining an expanded query

8   tile set beyond the query tile set if the number of neighbor objects is less than a target number;

9   locating neighbor objects within the expanded query radius;

10   determining a number of neighbor objects within the expanded radius corresponds to a

11   target number; and

12   continuing to expand the query radius and locate neighbor objects within the expanded

13   radius until the number of neighbor objects equals or exceeds the target number.

9. The method according to claim 8, further comprising:

calculating a distance of each neighbor object from the query object.

10. The method according to claim 9, wherein the distance of each neighbor object from

the center of the query object is calculated.

11. The method according to claim 8, wherein the distance is based upon interboundary

2   distance, boundary-to-boundary distance, or touch or intersect distance.

1   12. The method according to claim 8, further comprising:

2   redefining the initial query tile set as larger tiles to define a revised initial query radius if

3   the target number of neighbor objects is not found in a minimum number of expansions of the

4   query radius;

5   locating neighbor objects within the revised initial query radius;

6   determining a number of neighbor objects within the revised initial query radius;

7   defining a revised expanded query radius beyond the revised initial query radius if the

8   number of neighbor objects is less than the target number;

9   locating neighbor objects within the revised expanded query radius;

10   determining a number of neighbor objects within the revised expanded radius

11   corresponds to the target number; and

12   continuing to expand the query radius and locate neighbor objects within the expanded

13   radius until the number of neighbor objects equals or exceeds the target number.

13. The method according to claim 12, wherein the minimum number of expansions is three.

14. The method according to claim 12, further comprising:

determining whether an increased number of tiles exceeds a memory capacity of in which

the database is stored prior to increasing the number of tiles; and

if the increased number of tiles exceeds the memory capacity then redefining the tiles

with an increased size.

1   15. The method according to claim 8, further comprising:

2   calculating a distance of each located neighbor object from the query object if the number

3   of neighbor objects in the initial query radius exceeds the target number to determine the target

4   number of nearest neighbor objects.

1   16. The method according to claim 8, wherein the tiles are rectangular.

1   17. The method according to claim 8, wherein all of the tiles have the same shape and

2 size.

1   18. The method according to claim 8, wherein the database comprises locations in a

2 geographical region, the query object represents a first location in the geographical region, and

3 the neighbor objects represent other locations in the geographical region.

1   19. The method according to claim 8, wherein the database is indexed with a linear

2 quadtree.

1   20. The method according to claim 8, further comprising:

assigning each tile a tile code and an associated geometry as the tiles are defined.

1   21. The method according to claim 8, wherein the query radius is expanded a selected

2 distance and the method further comprises determining a number of tiles necessary to expand the

3 query radius the selected distance.

1   22. The method according to claim 8, wherein the query radius is expanded a selected

2 number of tiles.

1   23. The method according to claim 8, wherein the initial query radius and the expanded

2   query radius comprise the same number of tiles.

1   24. The method according to claim 8, wherein the query object is grouped within a

2   plurality of tiles.

1   25. The method according to claim 24, wherein the query object is grouped completely

2   or partially within the tiles.

1   26. The method according to claim 8, wherein the database comprises a spatial or

2   geographic database.

1   27. The method according to claim 8, further comprising:

        organizing the neighbor objects in order of distance.

1   28. The method according to claim 8, further comprising:

2   calculating a distance of each located neighbor object from the query to determine the

3   target number of nearest neighbor objects.

1   29. The method according to claim 8, wherein the query object comprises a geometry

2   that at least partially intersects at least one tile and the neighbor objects comprise geometries that

3   at least partially intersect at least one tile.

1   30. The method according to claim 29, wherein at least one tile that the neighbor objects

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2 intersect coincides with at least one tile that the query geometry intersects.

1 31. A computer program product for performing a process for locating neighbor objects of

2 a query object in a database in a computer system, comprising:

3 a computer readable medium; and

4 computer program instructions, recorded on the computer readable medium, executable

5 by a processor, for performing the steps of:

6 defining a query tile set comprising a plurality of tiles that define an initial query

7 radius that the query object is grouped within;

8 locating neighbor objects within the initial query radius;

9 determining a number of neighbor objects within the initial query radius;

10 expanding the query radius beyond the initial query radius by defining an

11 expanded query tile set beyond the query tile set if the number of neighbor objects is less

12 than a target number;

13 locating neighbor objects within the expanded query radius;

14 determining a number of neighbor objects within the expanded radius corresponds

15 to a target number; and

16 continuing to expand the query radius and locate neighbor objects within the

17 expanded radius until the number of neighbor objects equals or exceeds the target

18 number.

1 32. A system for performing a process for locating neighbor objects of a query object in a

2 database, comprising:

3   a processor operable to execute computer program instructions; and

4   a memory operable to store computer program instructions executable by the processor,

5 for performing the steps of:

6   defining a query tile set comprising a plurality of tiles that define an initial query

7 radius that the query object is grouped within;

8   locating neighbor objects within the initial query radius;

9   determining a number of neighbor objects within the initial query radius;

10   expanding the query radius beyond the initial query radius by defining an

11 expanded query tile set beyond the query tile set if the number of neighbor objects is less

12 than a target number;

13   locating neighbor objects within the expanded query radius;

14   determining a number of neighbor objects within the expanded radius corresponds

15 to a target number; and

16   continuing to expand the query radius and locate neighbor objects within the

17 expanded radius until the number of neighbor objects equals or exceeds the target

18 number.